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[2] Jeans, *Dynamical Theory of Gases*, p. 247.
[3] Adams, "The Quantum Theory," *Bull. Nat. Res. Council*, **1**, No. 5, Oct., 1920.
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[5] Ithaca, *Physic. Rev.*, **14**, p. 368.
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[8] *Proc. R. Soc. London*, **84A**, p. 595.
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THE ANGULAR DIAMETER OF ALPHA BOOTIS BY THE INTERFEROMETER

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Communicated by G. E. Hale, May 2, 1921

Since the measurement of the diameter of Betelgeuse[1] in December, 1920, observations for the determination of stellar diameters have been continued with the 20-foot interferometer attached to the upper end of the 100-inch Hooker reflector.

Several definite results have been obtained, and others, less definite because of poor observing conditions, have been partially checked by comparison with stars whose diameters are known to be too small for measurement with this instrument. Let the visibility of the zero fringes for any particular separation of the mirrors be reduced by seeing which is poor as compared with that on a fine night; it is then hopeless to make final measures. If, however, the interferometer is turned to a neighboring check star and the fringes are seen, and then turned to the star under consideration and they do not appear, the observer is justified in saying that there is a definite decrease in visibility.

The data thus far obtained are as follows: For α Tauri (Aldeberan) fringes of gradually decreasing visibility have been observed at 13, 14.5 and 19 feet. Further observations are necessary between the last two positions to determine whether the fringes vanish between these points or whether a longer beam will be necessary to obtain a measure of the diameter. If the fringes vanish around 16-18 feet, as observations under poor conditions lead one to suspect they will, then the fringes observed at 19 feet must lie beyond the point of disappearance, on the ascending branch of the visibility curve where it rises toward the second maximum.

For β Geminorum (Pollux) fringes have been observed at separations of 14.5, 16, and 19 feet, the visibility being definitely reduced for these distances of the mirrors, although at 19 feet it is still considerable. A longer beam will therefore be required for the measurement of the star's diameter.

For α Cetione observation at 13 feet in variable seeing showed a reduction in visibility of the fringes when compared with that of the check star.

For α Bootis (Arcturus) observations in February and March, with poor seeing, indicated a decided reduction in the visibility of the fringes with increasing separation of the mirrors. On April 15, a series of measures was made under conditions which were excellent, as indicated by the strong contrast of the zero fringes and by diffraction rings surrounding the central disk of the star images.

At 16 feet separation of the mirrors the visibility of the fringes was estimated at 20 to 25 per cent of the zero fringes; at 17.5 feet, 15–20 per cent, certainly less conspicuous than at 16 feet. At 19.0 feet the estimate was 5 per cent, the contrast being very flat, but the fringes were picked up with certainty as the path difference was varied with the optical wedge. At 18.25 feet, the result was 15 per cent, certainly greater than at 19.0 feet; and finally at 19.5 feet no fringes whatever could be observed from the interferometer mirrors. There was no bright star in the immediate neighborhood that could be used as a check, but the instrument was known to be in adjustment for the final measure, from the certainty with which the previous settings had been made.

The separation of the mirrors for disappearance of the fringes may therefore be placed at 19.5 ± 0.5 feet, although observations with a longer beam with which the second maximum could be observed, might possibly increase this value a trifle. By disregarding any possible darkening at the limb, the result will serve to indicate the maximum diameter of the star. The spectrum of α Bootis is Ko; its approximate effective wave-length may therefore be taken at 5.6×10^{-5} cm., about halfway between that of the sun (Go) and that assumed for α Orionis (Ma).

With this value of λ and a distance of 19.5 feet (594 cm.), the angular diameter of α Bootis is 0.0237. It is interesting to note the close agreement of this figure with the estimated values of Eddington (0.020) and Russell (0.019), and with Hertzsprung's value (0.026), calculated on the basis of the measured diameter of α Orionis (0.045).

Results for the parallax of α Bootis are as follows: Yale, 0.074; Flint, 0.095; Yerkes, 0. 100; Adams, spectroscopic, 0.158; the weighted mean is 0.116. The distance of Arcturus is therefore of the order of 1.65×10^{14} miles (2.65×10^{14} km.), and its linear diameter 19×10^{6} miles (30.6×10^{6} km.), or about 22 times the diameter of the sun.

All settings of the mirrors have thus far been made by hand, and considerable time is consumed between measures. Two screws are now being mounted on the beam, driven by a single motor, which for any separation will keep the outer mirrors equidistant from the fixed inner mirrors, and thus greatly facilitate the operation of the interferometer.

[1] These PROCEEDINGS, 7, 1921 (143–146).

CHANGES OBSERVED IN THE CRAB NEBULA IN TAURUS

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Changes in the structure of the Crab nebula (N. G. C. 1952, M. 1) have recently been detected by Lampland[1] from a comparison of seventeen photographs made with the 40-inch Lowell reflector during a period of eight years. An excellent negative of this nebula had been made by Ritchey with the 60-inch Mount Wilson reflector, 1909, October 13, using a Seed 27 plate and giving an exposure of three hours with the aperture stopped down to 54 inches. For comparison with this plate, the writer made a negative with the same instrument, 1921, April 7, using full aperture and a Seed 30 plate and giving an exposure of 1 hour 20 minutes. Though the exposure of this plate was necessarily shorter than that of Ritchey's because of the proximity of the object to the sun, the larger aperture and the faster plate made the photograph comparable in density with the earlier one.

The two plates were compared in the stereocomparator, and it was seen at once that changes in the relative luminosity of different parts of the nebula had occurred, particularly in the bright region north-west of the center; and also that certain filaments and condensations had apparently moved, the motion in general being away from the center, though not always exactly along a radius.

Measures in two coördinates were made with the micrometer of the stereocomparator upon twelve nebulous condensations and thirteen comparison stars. The nebulous points chosen are sufficiently symmetrical to permit measures of about equal accuracy in the two directions. They were chosen in the outer, faint parts of the nebula because of the difficulty of seeing isolated points in the bright portions. One comparison star is the north component of the double star that lies near the center of the nebula; each of the others lies near one of the measured nebulous points. The plate constants were derived from the measures of the comparison stars by a least-squares solution; with these constants the motions of the nebulous points were then referred to the mean of the comparison stars.